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RELATION BETWEEN THE TWIST AND CERTAIN PROPERTIES OF RAYON YARNS [1]

By Homer A. Hamm and Richard S. Cleveland

ABSTRACT

The results of a systematic experimental study of the relation between twist and certain physical properties of rayon yarns are given. In general the breaking strength determined by the multiple-strand method is not materially affected by an increase in twist up to about 20 turns per inch, but it decreases rapidly with an increase in twist beyond 20 turns. The proportional limit decreases with an increase in the amount of twist. The stretch at break decreases somewhat with increase in twist. The denier increases with increase in twist. The contraction resulting from twisting rayon yarn is greater for lower tensions and for higher deniers.

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I. INTRODUCTION

The amount of twist inserted in rayon yarns depends upon the intended use. It varies from the usual few turns per inch to from 30 to 100 turns per inch in some crêpe yarns. The relation between the twist and the strength, proportional limit,[2] stretch at break, denier,[3] and contraction of the yarn is of obvious importance. The results of a systematic experimental study of this relationship are given in this paper.

II. PROCEDURE

The yarns selected for this work are described in Table 1. They were all well-known American brands and were obtained early in 1930. All had a nominal twist of but a few turns per inch.

Samples having about 12 different twists were prepared from each of these yarns using a regular commercial twisting frame equipped with travelers that would give the smallest practical tension without allowing excessive ballooning. The twists ranged from about 5 to 100 turns per inch.

[1] Since this paper was written, H. J. Ball has published a paper on "Effect of Twist Upon the Properties of Rayon Yarn" in the bulletin of the Lowell Textile Institute, Series 34, No. 4; May, 1931.

[2] The proportional limit of a yarn is taken to be the stress (or load) at which the extension (or stretch) ceases to be proportional to the stress.

[3] The denier is the unit of size of the yarns. It is the weight in grams of 9,000 m.

TABLE 1.—*Description of yarns*

Sample No.	Type	Twist, turns per inch	Number of filaments	Denier
1	Cellulose acetate	2.0	40	145
2	Cuprammonium	5.2	112	149
3	Viscose	3.3	150	150
4	Delustered viscose	2.4	24	148
5	do	2.8	36	159
6	do	3.9	60	155

The samples were thoroughly conditioned in an atmosphere of 65 per cent relative humidity and a temperature of 70° F., and were tested under these conditions.

The twist in 10-inch lengths of the yarn was determined and the results were expressed in turns per inch. The average of 10 determinations was taken to be the twist in the yarn.

The denier of the yarn was calculated from the average weight of two 80-yard skeins reeled from each bobbin.

The breaking strength, proportional limit, and stretch were determined using a pendulum type of tester with stress-strain recording attachment. The multiple strand method [4] was used and 150 ends were broken in each test. The speed of the lower jaw was 1 inch per minute, and the initial distance between the jaws was 4 inches. The breaking strength, proportional limit, and stretch were taken to be the average obtained from two stress-strain graphs for each yarn.

Additional tests were made to determine the effect of the load applied during twisting on the contraction of the yarn. A dead load was applied to the end of a 10-inch length. The yarn was then twisted and the contraction observed for increments in twist of five turns per inch. The loads used were 15 and 43 g. Viscose yarns ranging from 63 to 300 denier were studied.

III. RESULTS

1. BREAKING STRENGTH

The relation between breaking strength and amount of twist is shown graphically in Figure 1 (*a*), and in (*b*) is shown the percentage decrease in breaking strength with increase in twist. The solid curve in (*b*) represents the average values for all of the yarns and the broken curves minimum and maximum values. It will be seen that the breaking strength is not materially changed with an increase in twist up to about 20 turns per inch, but that it decreases rapidly with increase in twist beyond 20 turns. With a twist of 60 turns per inch the decrease in strength ranges from 40 to 70 per cent for the yarns studied.

2. PROPORTIONAL LIMIT

Figure 1 (*a*) shows the proportional limit and (*d*) the percentage decrease in proportional limit with increase in twist. The propor-

[4] Schoffstall, C. W., and Hamm, H. A. A Multiple Strand Test for Yarns. B. S. Jour. Research, vol. 2, pp. 871–885; 1929.

tional limit decreases with increasing twist about 1 per cent per turn. At 60 turns per inch the decrease in proportional limit varies from about 50 to 80 per cent.

3. STRETCH AT BREAK

The relation between the stretch at break and the twist is shown in Figure 1 (*g*). There is a general tendency for the stretch at break to decrease as the twist is increased though the amount of stretch and the change in stretch varies with the yarn studied.

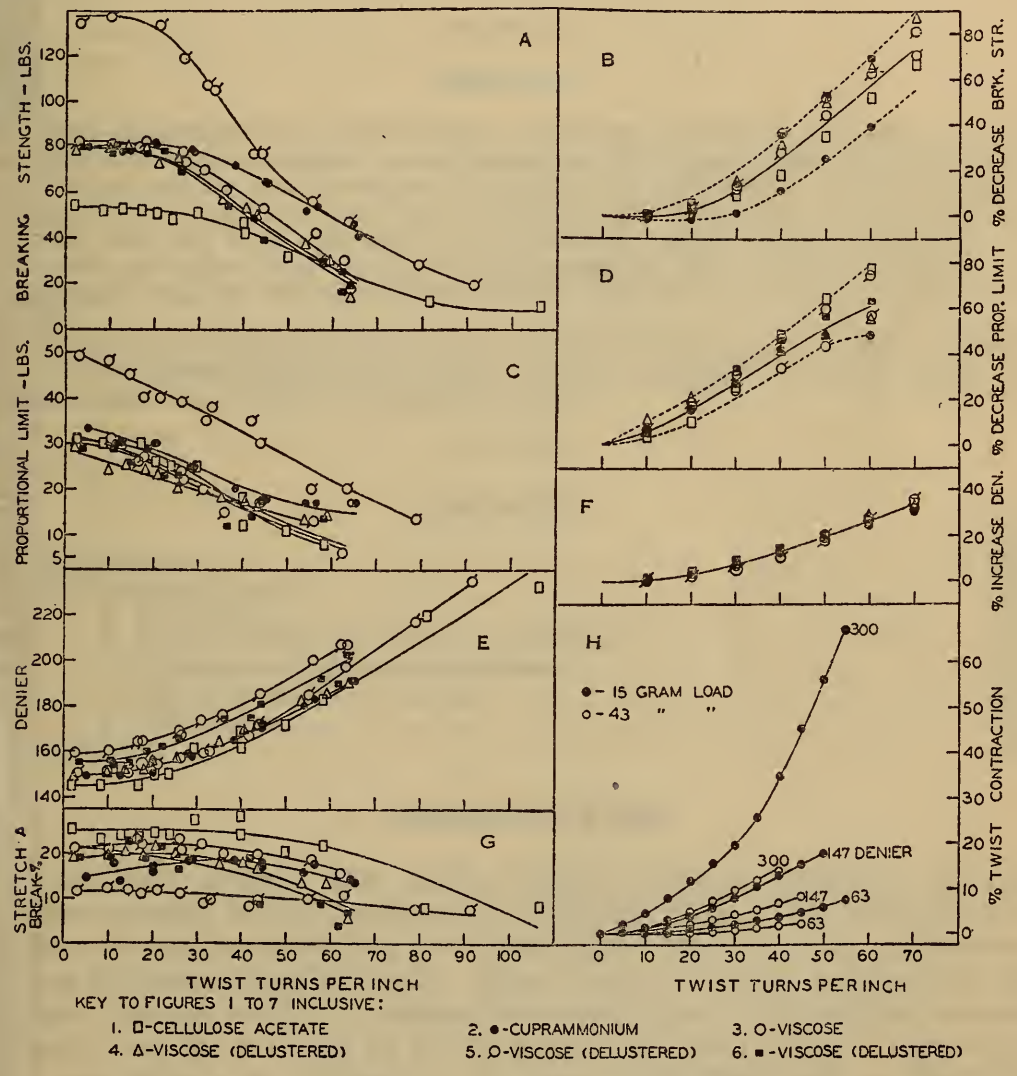
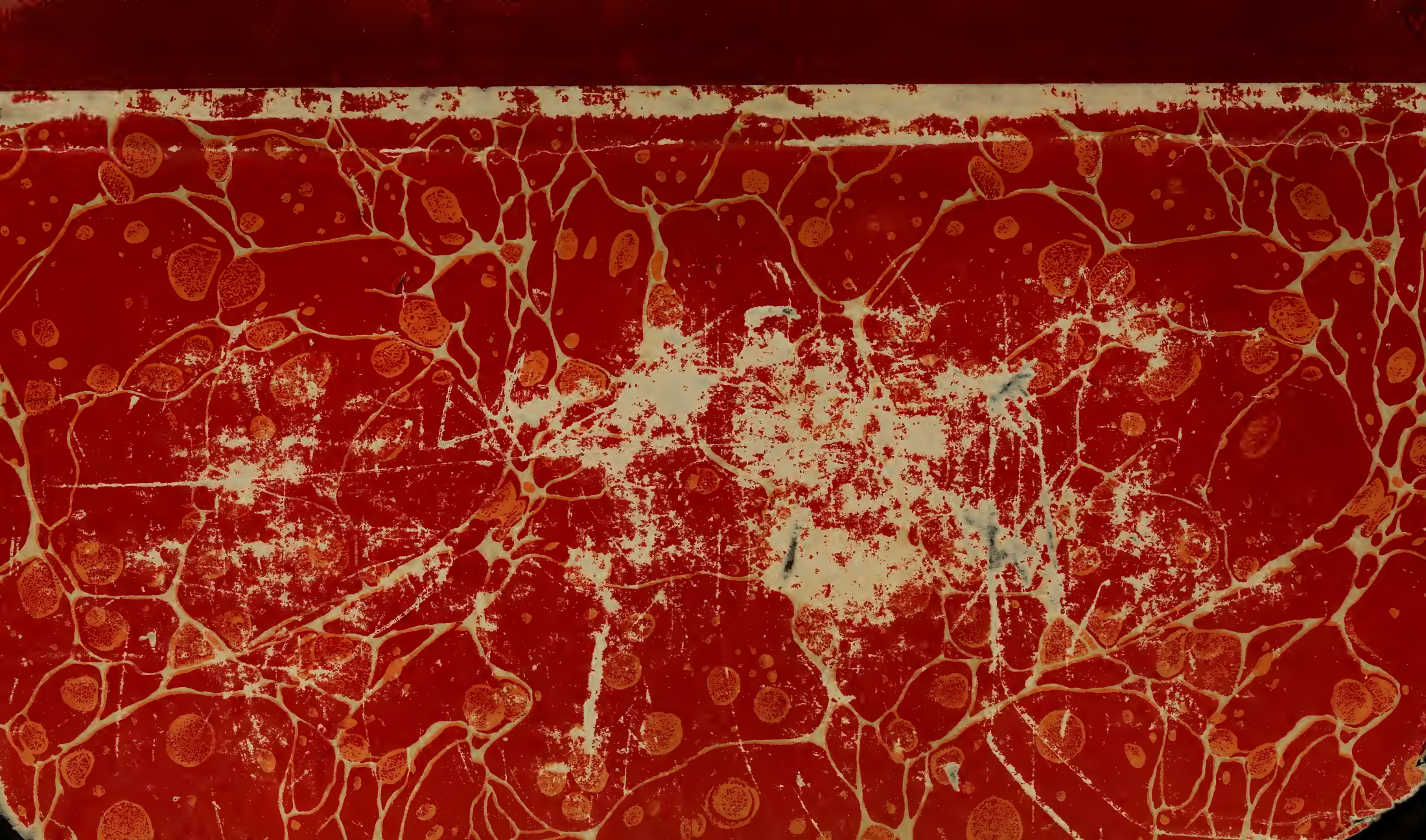


FIGURE 1.—*The effect of twist on rayon properties*

4. DENIER

The denier of the yarns at different twists and the percentage increase in denier with increase in twist are shown in Figure 1, (*e*) and (*f*), respectively. Twisting increased the denier of all of the yarns at about the same rate. This increase in denier should not be lost sight of in considering the relation between amount of twist and strength.

5. CONTRACTION

The percentage contraction resulting from twisting viscose rayon yarns under dead loads of 15 and 43g is shown in Figure 1 (*h*). The contraction is greater with the smaller load and with the higher denier yarn.

WASHINGTON, July 16, 1931.